

Space Weather Forecast

Issued on Friday, 10 May 2024 at 13:29 Local

This forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Moderate (G2) to Strong (G3) Geomagnetic Storm expected late 10 May into 11 May, with a chance of reaching Severe (G4) given several concurrent CME arrivals. Further Strong X-ray flares likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has remained high in the past 24 hours, with X-ray activity showing frequent Moderate-class activity, peaking with a Strong Class at 10/0706UTC from a large and complex region in the southwest. This was preceded by a second Strong-class flare 09/1743UTC from the same active region. There are currently seven sunspot groups, with a large and complex region now no longer visible on the northwestern solar horizon as another significantly smaller and simpler region is arriving over the eastern horizon.

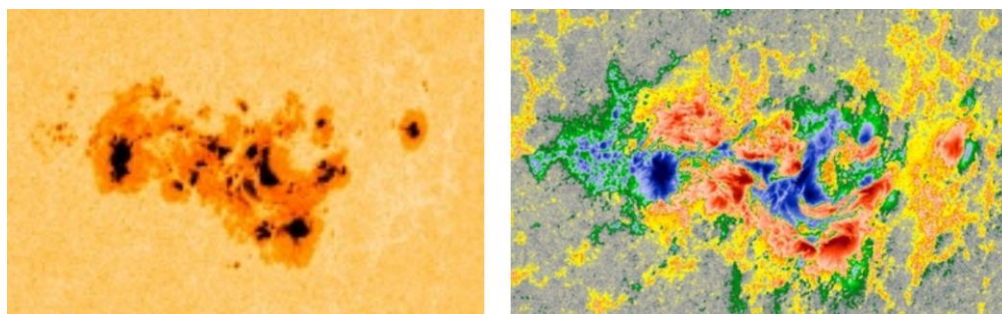


Figure 1: 10/1200UTC visible and magnetic imagery showing high degree of complexity in the largest and most complex sunspot – the expected source of much of the coming four days' space weather activity. Earth would easily fit into this group several tens of times over.

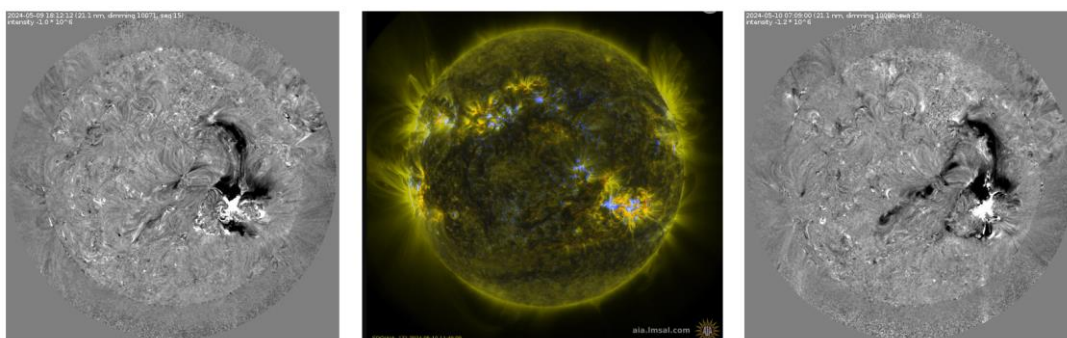


Figure 2: 'Coronal dimmings' (often CME signatures) of the two Strong-class flares from the last 24 hours from the large and complex region shown in Figure 1. Also shown is false colour extreme UV and magnetic imagery for the facing side for 10/1200UTC.

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The sunspot responsible for the Strong-class flares is by far the largest and most complex, as has been the case for recent days. While recent imagery perhaps suggests a very slight reduction in overall area, its longitudinal span on the face of the Sun has topped 24 degrees (the full face being 180 degrees). Imagery suggests there has been some consolidation of late of the intermediate spots, however there is shear and major distortion in the leaders in particular, and its most recent flare effort at 11/0706UTC proves that it remains a very potent spot group. Activity in other active regions paled in comparison, however perhaps the most significant trend in the remainder of the front side groups was continued emergence of a group in the northeast.

The two Strong-class flares of the past 24 hours both have Coronal Mass Ejections (CMEs) associated with them. The earlier and smaller (in terms of X-ray flux) of the two has been modelled in MOSWOC Enlil and crosses the radius of the Earth's orbit around the turn of the UTC day 11 into 12 May as a standalone feature (i.e. not an agglomeration of several CME fronts). This is directed largely ahead of the track of the Earth's orbit, but with a reasonably strong glance modelled. The precise arrival time is under review.

The second CME is now emerging on satellite imagery. This appears to share the character of much of the recent CME activity, and will be analysed once further imagery becomes available. This event may catch up with the CME from the other Strong-class flare in the period to amplify any activity - this aspect is TBC.

The only other noted possible CME event of the period was one from behind the northeastern solar horizon seen around 09/1800UTC. This is visible on satellite imagery but plays no part in the forecast.

Solar Wind / Geomagnetic Activity: Solar winds were relatively steady at slightly elevated levels throughout. The number of particles in the solar wind showed a very slight rising trend, mainly confined to typical background values, but with an eventual rise to become slightly elevated by the period's end. The magnetic field was relatively erratic in magnitude but remained within background levels, peaking mid-period. The north-south component was variable but with no strongly aligned or anti-aligned periods with Earth's field (usually to lesser or greater impact respectively).

The net result of the above solar wind measures was quiet throughout.

Energetic Particles / Solar Radiation: Solar radiation levels showed a slow and steady upward trend in the wake of recent strong flares, rising from around 0.5pfu to 4pfu over the period as a whole (i.e. below S1 at 10pfu).

Four-Day Space Weather Forecast Summary

Solar Activity: Further Strong-class flares are likely, while Moderate-class are expected on all days of the period. The sunspot responsible is present throughout, and there are signs of large eastern solar horizon arrivals to at least in some way mitigate for the recent loss of another large region over the northwestern solar horizon.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast is CME-dominated, with the main uncertainties being 'when' rather than 'if' CMEs arrive. Multiple Earth-directed CMEs were observed leaving the Sun between 08 and 09 May associated with solar flares from the largest sunspot in the southwest. Added to this is a large 'filament liftoff' (arc of plasma) from the northeast on 08 May. Due to the relative speed of the various CMEs most are expected to combine into a single larger arrival towards the end of the UTC day on Day 1 (Friday 10 May).

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The first of the Strong-class flare CMEs mentioned in the solar activity section is perhaps the main exception to this, and should arrive later at around 12/0001UTC. The latest and largest flare of the current 24-hour period (also Strong class) is undergoing assessment, but could sweep up its forebear in a manner similar to events forecast on 10 May - this aspect is to be confirmed.

Other drivers of geomagnetism are expected to be masked and pale in comparison to the CME effects, however should any sizable windows emerge that escape CME influence (considered unlikely), slightly elevated solar winds are expected to fall to Background levels on Day 1 (10 May). A fast wind minor coronal hole enhancement is possible from late Day 2 (11 May) or early day 3 (12 May).

Geomagnetic activity is expected to remain quiet at first on 10 May. Later in the UTC day effects from multiple Earth-directed CMEs are expected to increase activity to G2-G3/Moderate to Strong levels, with a chance of G4/Severe Geomagnetic Storm intervals. Similar levels of activity should persist into the start of day 2 (11 May). The Strong class CME of the latter stages of 09 May should then follow around 12/0001UTC, to give a further salient peak of Likely G2, with this potentially being bolstered by the unassessed later Strong class in the current UTC day - TBC in future guidance. While some reduction in geomagnetic activity is then likely into Day 4, Monday 13 May, confidence at the end of the period is low and the forecast may change should further large Earth-directed CMEs occur.

Energetic Particles / Solar Radiation: Solar radiation storms now carry an increased chance of breaching Minor S1 given recent increases observed as well as the prospect of inbound CMEs sweeping up and compressing those in the interplanetary medium. There is now a corresponding slight chance of Strong S3 for this reason during the first two UTC days. The chances from here otherwise comprise a comparatively lower but rising risk of further Minor S1-scale events from further proton-rich flare events from the surviving large sunspot group, overlaid on a decreasing contribution from the other now-departed region in the northwest (remembering Earth can be affected by far-side generated solar radiation events).

Geomagnetic Storms:

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	95	95	80	40
Strong	G3	No	60	60	30	10
Severe	G4	No	30	30	10	5
Extreme	G5	No	10	10	5	1

Radio Blackouts - X Ray Flares:

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	95	95	95	95
Very Active	R3 to R5 X	Yes	60	50	50	50

Solar Radiation Storms - (High Energy Protons):

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	50	50	40	40
Very Active	≥ S3 *	No	20	20	5	5

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)